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FINAL ADDENDUM TO THE FINAL REVISED FEASIBILITY STUDY FOR SOIL AND GROUNDWATER HORSESHOE ROAD AND ATLANTIC RESOURCES SITES REMEDIAL INVESTIGATION/FEASIBILITY STUDY SAYREVILLE, NEW JERSEY

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Final Addendum to
Final Revised Feasibility Study for Soil and Groundwater
Horseshoe Road Complex and
Atlantic Resources Corporation Sites
Remedial Investigation/Feasibility Report
Sayreville, New Jersey

Section 1
Purpose

The purpose of this Addendum to the Final Revised Feasibility Study (FS) for Soil and Groundwater for the Horseshoe Road Complex and Atlantic Resources Corporation (ARC) Superfund sites (referred to herein as "the sites") is to provide justifications for the technical impracticability (TI) of remediating contaminated groundwater at the sites. This addendum supplements Section 4.3.2 of the FS report. A Draft Addendum to the Final Revised FS for Soil and Groundwater was submitted to the US Environmental Protection Agency (EPA) on May 15, 2003. This Final Addendum incorporates EPA's comments on the Draft Addendum. Copies of cited figures and tables from the Remedial Investigation (RI) report and FS report are attached to this addendum.

The TI justification is based on the fact that the groundwater alternatives developed in the FS report would not meet cleanup levels within a reasonable time frame. Alternative GW1 is no action, and Alternatives GW3 and GW7 involve an interceptor trench with a groundwater extraction/treatment system. Due to the low hydraulic conductivity and specific capacity of the shallow aquifer, the groundwater extraction and treatment system could only achieve hydraulic control of the groundwater and is not expected to expedite groundwater cleanup. As indicated in the FS report, the time required to cleanup groundwater at the sites is strongly dependant upon natural attenuation processes, primarily biodegradation. As a result, EPA has requested that a modified version of Alternative GW2, designated as Alternative GW2a - Long-term Monitoring and Institutional Controls, be subjected to further evaluation as a potential groundwater remedy for the sites, as it will: 1) achieve comparable protection of human health and the environment to Alternatives GW3 and GW7 and 2) allow for routine monitoring to verify protection of human health and the environment.

The soil remedy for the sites includes removal of source area soils from the saturated and unsaturated zones. The soil remedy will expedite the groundwater remediation in two ways:

- The source of groundwater contamination will be removed.
- During the soil removal process, highly contaminated groundwater will also be removed.

Groundwater contamination is not expected to significantly impact human health or the environment. The aquifer is not used as a drinking water source and, due to its low specific capacity, would not be a potential drinking water source in the future. As indicated in Section 1 of the FS, the low hydraulic conductivity and gradients result in relatively slow groundwater velocities across the sites. In addition, the high organic carbon content and geochemistry associated with the aquifer matrix support adsorption and biodegradation of contaminants, and, thereby, tend to retard downgradient contaminant transport from source areas. This tendency is readily apparent based upon the relatively short contaminant migration distances and biodegradation daughter products observed from groundwater monitoring, and the fact that waste releases at the sites occurred from the 1950s to the mid-1980s. In summary, any contaminant migration presently occurring at the sites is expected to be slow. Likewise, future impact to wetland areas would be unlikely, and sufficient warning could be provided through routine monitoring.

Section 2
Background

The Horseshoe Road Complex and ARC sites are located in a remote area in the northern outskirts of the Borough of Sayreville, Middlesex County, New Jersey. The abandoned sites are situated on low lying terrain near the Raritan River. The sites consisted of several abandoned industrial buildings and warehouses. The buildings were removed as part of the remedy for Operable Unit 1 (OU1). The sites are bordered to the north by the Raritan River and property owned by the Middlesex County Utilities Authority (MCUA), to the east by the Kearny Branch of the Raritan River Railroad (Conrail), and to the west and south by wooded and residential areas. An MCUA right-of-way easement for a sanitary force main runs in a north/south direction through the central portion of the sites.

The Horseshoe Road Complex site consists of three Areas of Concern (AOCs):

- Horseshoe Road Drum Dump (HRDD) - AOC 1
- Atlantic Development Corporation (ADC) - AOC 2
- Sayreville Pesticide Dump (SPD) - AOC 3

The ARC site is not part of the Horseshoe Road Complex site, but was included in the Remedial Investigation and Feasibility Study as AOC 4. On September 29, 1995 the Atlantic Resources property was listed on the National Priorities List (NPL) as part of the Horseshoe Road Complex site. Due to legal action taken by the Potentially Responsible Parties (PRPs), the Atlantic Resources property was removed from the listing in April 1997 and added to the NPL as an independent site in September 2001. The demolished buildings and slabs were associated with the ARC and ADC properties. The AOCs are shown in Figure 1.

2.1 Physical Characteristics and Hydrogeologic Framework

The topography of the sites is relatively flat and grades towards the Raritan River. Throughout the sites, several unnamed drainage channels flow generally from southeast to northwest. The Final RI Report (CDM 1999) has a more detailed description of the on-site drainage channels, which ultimately flow into the Raritan

River. One of the unnamed drainages primarily flows through the SPD and ADC; water from this wetland generally flows northward through an underground concrete culvert and then northwest, through the wetland in the northwest portion of the sites, to the Raritan River. Another of the unnamed drainage channels, referred to as the ADC/ARC/HRDD drainage, originates between the ADC and the ARC and flows along the western side of HRDD, into the marsh area and tidal flats, and ultimately into the Raritan River. Another predominant drainage channel, referred to as the ARC/HRDD drainage, is located to the north of ARC and flows northward, along the northeastern edge of HRDD, into tidal flats, and ultimately into the Raritan River.

The Horseshoe Road Complex and ARC sites are located within a complex hydrogeologic environment that was developed by the interactions of several distinctly different geologic units. The sites are underlain by the Woodbridge member of the Raritan Formation, which is about 90 feet thick. The Woodbridge was observed to consist of gray silt and clay. The shallow zone geology of the sites is a complex system of interfingering lithologies of the Woodbridge unit. The shallow zone, including areas where fill material was noted, is mainly composed of variable amounts of gray and mottled gray yellow brown silt, fine sand, and clay. In the southern part of the sites, the predominant lithology of the shallow zone is fine to medium sand. Organic silt, indicative of marsh conditions, was also observed in the shallow zone in the center and northern edges of sites.

Groundwater is present in the shallow sedimentary formations beneath sites under both unconfined and confined (semi-confined) conditions. Unconfined conditions exist only in the uppermost sediments. In the areas where unconfined conditions were noted, the water table was close to or coincident with the ground surface. Confined or semi-confined conditions exist in the fine sand lenses of the upper Woodbridge Clay. Groundwater beneath the sites flows directly or indirectly toward the Raritan River and discharges to surface water near the sites.

The results of the specific capacity step drawdown tests that were performed in six test wells had very low specific capacities. Only three wells had the capacity to produce 0.25 gallon per minutes (gpm) sustained yield; the three other wells were pumped dry at rates below 0.25 gpm. In general, groundwater levels in the observation wells were not affected by the test pumping. This is most likely due to the limited pumping intervals associated with typical step drawdown tests combined with the low hydraulic conductivities of the silt, clay, and fine sand materials that underlie the sites. Using an estimated aquifer thickness of 12 feet (the average combined thickness of the fine sand layers in the borings), the range of hydraulic conductivity values calculated (1.6 to 17.2 gallons per day per square foot [gpd/ft^2]). The range is typical of fine sand and mixtures of sand, silt, and clay. Once average hydraulic conductivities were determined, groundwater velocities were then calculated using the averaged hydraulic conductivities, AOC-specific hydraulic gradients from groundwater elevation contour maps, and an effective porosity of 10 percent for the fine sand. The calculated groundwater flow velocities were 96.4 feet per year (ft/yr) in HRDD, 106 ft/yr in ARC, 51.4 ft/yr in ADC, and 45.0 ft/yr in SPD.

These velocities are expected to be upper limit values. The hydraulic conductivity and velocity calculations are described in more detail in Section 3.5.3.3.3 in the RI report (CDM 1999).

CDM conducted a 14-day tidal influence survey to determine the extent of tidal influence on the groundwater flow regime. A significant, clearly measurable tidal influence was observed only in two wells, both of which are located near the river. The maximum tidal fluctuation observed in the river, 9.5 feet, induced a response in well CW-07 of about 0.9 foot, and in MW-02 of about 0.1 foot. A pronounced tidal effect could not be identified in any other well.

The data collected at the sites enabled CDM to construct a conceptual hydrogeologic model. Precipitation either leaves the sites by surface runoff to the Raritan River or infiltrates into the unconfined sediments that overlie the top of the Woodbridge Clay. Where the topography of the upper surface of the Woodbridge Clay provides continuous channels or relatively even slopes, some of this perched groundwater could migrate to the west or northwest, and discharge to the surface. Any depressions without outlets in the top of the Woodbridge Clay will likely act as subsurface retainage basins for the shallow perched groundwater. Some of the perched water may provide recharge to the Woodbridge sand lenses. Hydraulic gradient data show that the discharge area for the sand lenses is west and northwest of the sites.

Surface elevations of about 30 to 35 feet above mean sea level along the eastern part of the sites grade downward to about 15 feet above msl in the southwest and western portion, and to near mean sea level to the northwest. A portion of the surface water discharge from the northern part of the sites may directly discharge to the Raritan River by overland flow. The majority of the surface water is directed west through swales and drainage channels that flow through the wetland area to the Raritan River.

Through combined effects of topographic and geologic conditions, the Raritan River is the direct or indirect recipient of surface water and groundwater discharge from the Horseshoe Road Complex and ARC sites.

The Final RI Report for the Horseshoe Road Complex site, as discussed above, determined that neither of the two regional aquifers (the Old Bridge aquifer and Farrington aquifer) are threatened by contaminants from the site. Four significant observations support this conclusion:

- The Old Bridge aquifer, which is the most productive aquifer in Middlesex County, is both stratigraphically and topographically above the site; therefore, the aquifer cannot receive recharge from the site.

- The lithology of the subsurface at the sites is predominantly silt and clay with very low permeability. The average permeability measured in three clay samples collected at the sites was 6.5×10^{-8} centimeters per second (cm/sec).

- The greatest observed depth of penetration of contaminants was 30 feet. The depth of penetration was significantly less than 30 feet in most observations.

- The Farrington aquifer is not present beneath the sites. The Woodbridge Clay, a regional aquiclude greater than 100-foot thickness, rests directly on the weathered surface of an essentially impermeable Triassic diabase sill.

2.2 Summary of Site Contamination

For over 40 years, various operations were conducted at the Horseshoe Road Complex and ARC Sites, including the manufacturing of epoxy resins, roofing materials, paint pigments, and pharmaceuticals. Poor waste handling practices and the dumping of waste materials resulted in site-wide contamination. A summary of the extent of surface and subsurface soil contamination is provided in Figures 1-26 and 1-27 of the FS.

Surface soil contamination contains a wide range of organic and inorganic compounds throughout the AOCs. Surface soil is defined as soil above the groundwater table. Surface soil depths are estimated to be from 0 to 1 foot below ground surface (bgs) in ADC and ARC, from 0 to 4 feet bgs in SPD, and from 0 to 12 feet bgs in HRDD.

Subsurface soil (defined as soil below the groundwater table) contamination within HRDD includes organics and inorganics with the highest concentrations generally detected in the test pit samples throughout the dump area. Contamination was noted in soil boring samples collected within HRDD. Subsurface soil quality within ADC was characterized by wide-spread detections of organic compounds and inorganics. Organic contamination was noted to 23 feet bgs. Volatile organic compounds (VOCs) generally were absent from the surface soils, but exceeded screening criteria in the subsurface soils. SPD subsurface soil quality was characterized by sporadic detections of volatile and semi-volatile organic compounds (SVOCs), and wide-spread detections of inorganics at concentrations above screening levels. Maximum detections of organic and inorganic contamination were noted to depths of 2 feet bgs in test pits samples and to 30 feet bgs in soil boring samples. Subsurface soil quality within ARC was characterized by wide-spread detections of organic and inorganic compounds, with the highest concentrations generally detected in samples collected east of the process area, west of the incinerators, and adjacent to the tank excavation area. The maximum organic and inorganic exceedances were noted to depths of 20 feet bgs.

A multi-phased groundwater investigation was conducted to evaluate the occurrence, quality, and flow patterns of shallow groundwater at the sites. The investigation concluded that two major plume areas are present at the sites. The plumes are characterized primarily by chlorinated and non-chlorinated organic contamination. Levels of metals are relatively low, with some indication of elevated metals on the northern portion of the sites near ARC. Figure 4-54 of the RI Report presents a summary of the groundwater contamination at the sites. Concentrations of total VOCs are based on the groundwater data collected during the RI. The larger plume covers virtually the entire ADC AOC. The highest total contaminant values are widely distributed within the plume, suggesting multiple source areas within the AOC. The high contamination areas typically correlate with high concentrations in the subsurface soils. The relatively low concentrations observed in monitoring wells downgradient suggest that the plume is not highly mobile. A smaller and less concentrated plume, centered in the SPD AOC at the southeast corner of the site, appears to merge with the ADC plume.

Sediment and surface water samples were collected within the three major drainage features at the sites. In general, contamination that exceeds screening levels was identified in most sediment and surface water sampling locations. Sediment contaminants include pesticides, polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs) and metals. Surface water contaminants in the drainage channels include VOCs, SVOCs, PCBs, pesticides and metals. The analytical results also suggest that site-related contamination from surface water run-off has migrated to and has impacted both surface water and sediment quality of the nearby drainage channels and wetlands. The analytical results also suggest that site-related contamination potentially has migrated to and impacted the Raritan River.

One surface water sample was collected in the wetlands during the RI and VOCs were not detected. Additional samples were later collected in the wetlands during a storm event. These samples contained VOCs that exceeded surface water quality limits. The VOCs were most likely related to stormwater run-off from the sites instead of from contaminated groundwater discharge since the samples were collected during a storm event.

In addition, releases of copper, lead, methoxychlor, lindane, phenol, bis(2-ethylhexyl)ether, chloroform, 1,2-dichloroethane, and mercury to the Raritan River also have been reported. A more detailed account of the sites' history is presented in the Final RI Report (CDM 1999).

Section 3
ARARs and Cleanup Criteria

Both federal and state chemical-specific applicable and relevant or appropriate requirements (ARARs) for groundwater were identified in Tables 2-1 and 2-2 of the FS report. New Jersey groundwater regulations are considered to be applicable in the remediation of groundwater contamination at the sites. Federal and state primary drinking water regulations are considered to be relevant and appropriate for consideration in the remediation of the groundwater. While the site groundwater is classified as a class IIA drinking water source, groundwater in the vicinity of the sites is not currently used as a source of potable water.

Groundwater preliminary remediation goals (PRGs) were determined for compounds identified as contaminants of potential concern (COPCs) in the RI and further refined in the FS. These included VOCs, SVOCs, and inorganic compounds. PRGs were selected by evaluating the available groundwater ARARs which included New Jersey Primary Drinking Water Standards, New Jersey Groundwater Quality Criteria Class II

A Groundwater, and New Jersey Saltwater Criteria for Human Health and Aquatic Life. The maximum groundwater background levels were considered in determining the PRGs. The lowest value from the standards and criteria were selected as the groundwater PRGs, unless the maximum background level was higher. In these situations, the background value was selected as the groundwater PRG. Site background was determined as the maximum level detected from two rounds of samples collected during the RI from four background wells (GW-1, GW-12, CW-13, and CW-14). The list of groundwater PRGs is provided in Table 1-8 of the FS.

Section 4
Site Conceptual Model

Figure 6-1 of the RI Report depicts a site conceptual model. Historical aerial photographs indicate that the Horseshoe Road Complex site was an active disposal area as early as 1957. The wastes were disposed of on the ground. Four main source (dump) areas are present at the sites, namely HRDD, ADC, SPD, and ARC. Contaminants have spread as precipitation leaves the sites by surface water runoff or infiltrates into the unconfined sediments that overlie the top of the Woodbridge Clay. Surface water generally drains in a northeast direction and ultimately discharges into the downstream marsh and Raritan River. Hydraulic gradient data show that groundwater typically discharges to the surface west and northwest of the sites, eventually impacting the downstream marsh and Raritan River.

The areas and thickness of soil contamination vary between the four source areas. The extent of surface and subsurface soil contamination is depicted in Figures 1-26 and 1-27 of the FS report. The depths of contamination are 12 feet at HRDD, 7 feet at ADC, 10 feet at SPD, and 7 feet at ARC.

Wastes from the disposal areas leached into groundwater over the years. Figure 4-54 of the RI report depicts the extent of groundwater contamination. The groundwater is mainly contaminated by organic contaminants, in particular VOCs. There are two large and three small areas exceeding 1,000 ug/L total VOCs , which coincide with the soil source areas. In general, the highest concentrations were observed in the shallow temporary well points and in the monitoring wells completed with the shallowest screen settings, typically from approximately 3 to 13 feet bgs. Although contaminants exist to depths of 20 to 30 feet in the plume under the ARC site, vertical migration is inhibited by the low hydraulic conductivity of the underlying formation, and by the discontinuous nature of the sand lenses in the upper Woodbridge Clay. The plumes have not significantly migrated. The areas that exceed the Maximum Contaminant Level (MCL) of 1 ug/L total VOC for groundwater have migrated less than 500 feet from the source areas over the past 25-plus years. Two primary conditions limit migration of the contaminants at the sites: 1) soils have very low hydraulic conductivities since the site is underlain by the Woodbridge unit, which consists primarily of dark silts and clays, and 2) intrinsic biodegradation of VOCs also retards contaminant migration in groundwater to some extent, as supported by the observed presence of reductive dechlorination daughter products in groundwater and results of screening-level modeling using EPA's BIOSCREEN model (see Appendix C of the FS).

Section 5
Spatial Area Over Which TI Waiver is Applied

The area considered for the TI waiver covers approximately 30 acres, as depicted in Figure 1. The TI waiver covers the areas where organic contaminant concentrations exceed the MCL limit of 1 ug/L for total VOCs. The area includes the HRDD, ADC, SPD, and ARC and extends into wooded areas west and south of the sites, including Block 246 (part of Lot 1, Lot 1.01, part of Lot 1.03) and Block 256 (part of Lot 2.02, Lot 2.03, Lot 2.04). The area includes portions of the Middlesex County Utilities Authority (MCUA) right-of way easement for the sanitary force main that runs in a north/south direction through the sites. The TI waiver area extends north to include Block 256 (Lot 3, part of Lot 3.01), and Block 257.01 (part of Lot 1.07, part of Lot 5, part of Lot 6) and is then generally bounded by the Raritan River. The TI waiver area includes part of the Kearny Branch of the Raritan River Railroad (Conrail, Block 62.02, Lot 20), and extends into the wooded areas on the other side of the railroad (part of Block 256.01, Lot 1.02 and part of Block 257, Lot 7). The entire TI waiver area only includes the shallow aquifer down to 30 feet bgs, the maximum depth at which groundwater contamination is present as described in Section 4.

Section 6
Evaluation of Restoration Potential

Section 6 evaluates the restoration potential of the sites. This section illustrates that contaminant sources have been contained or removed to the extent practical and analyzes the performance of ongoing or completed remedial actions. This section also describes the time frames to attain cleanup levels using available technologies and will demonstrate that no other remedial technologies could attain the cleanup levels at the sites within a reasonable time frame.

6.1 Containment and Removal of Contamination Sources to the Extent Practicable

The sources of groundwater contamination will be removed as part of the remedial action for soils. The soil remediation will include the following components:

- Excavation and off-site disposal of contaminated surface soils (above the PRGs) from SPD, ADC, HRDD and ARC
- Excavation and off-site disposal of contaminated subsurface soils (above the PRGs) from ADC, ARC and SPD, including associated groundwater
- Excavation and off-site disposal of sediment from onsite drainage channels

Figure 4-3 of the FS report depicts the area of excavation and Table 2-4 summarizes the volume of soil to be excavated.

The surface soil excavation depths are considered the soil above the water table, and are estimated to be from 0 to 1 ft bgs in ADC and ARC, from 0 to 4 ft bgs in SPD, and from 0 to 12 ft bgs in HRDD. The subsurface soils, which exceed the remediation goals, and are located below the water table, are considered to be groundwater source areas and will be excavated. The subsurface soil depths are estimated to be from 1 to 7 ft bgs in ADC and ARC and from 4 to 10 ft bgs in SPD. No subsurface soil areas will be excavated in HRDD.

At the completion of the soil remedy, groundwater contamination sources will be removed.

6.2 Analysis of the Performance of Ongoing or Completed Remedial Actions

A Record of Decision (ROD) for OU 1 - Buildings and Structures was signed September 1, 2000 to address contaminated buildings and above ground structures at the sites. In 2001, removal of the buildings and structures was performed at the ADC site. Demolition of the ARC buildings was complete in May 2003. The concrete slabs of the buildings were not removed during demolition. The removal of the buildings has minimal impact on the soil or groundwater contamination present at the sites.

No ongoing or completed remedial actions for soil or groundwater have been conducted at the sites. Future remedial action for soils is described in Section 6.1. An estimated 46,000 cubic yards of surface soils will be removed. This will significantly reduce the potential for contaminant migration to the saturated zone and as surface water runoff. An estimated 16,000 cubic yards of saturated soils will be removed, substantially reducing waste sources and the source of groundwater contamination.

In addition to removing the source of groundwater contamination, the excavation will also reduce the groundwater contamination by direct removal of contaminated groundwater during soil excavation below the groundwater table. The remedial investigation indicated that two major plumes are present at the sites, as depicted in Figure 4-54 of the RI report. The two major plumes are located at ADC and ARC. A small plume is located at SPD. The subsurface areas to be excavated coincide with these three plumes. The areas to be excavated are approximately 100 feet by 200 feet each at ADC, ARC, and SPD. Therefore approximately 800,000 gallons of the most highly contaminated groundwater will be removed under this alternative. In addition, dewatering of surrounding contaminated groundwater, in addition to removal of saturated soil, will be required to complete subsurface soil excavations that extend below the water table.

6.3 Predictive Analyses of Time Frames to Attain Cleanup Levels Using Available Technologies

Alternatives GW3 and GW7 involve removing contaminants using an interceptor trench and associated groundwater extraction/treatment system. The FS report indicates that it would take a very long time for the groundwater at the sites to attain the cleanup levels under these alternatives considering the low hydraulic conductivity and specific capacity of the shallow aquifer. The groundwater extraction and treatment system, which relies on flushing of contaminants from saturated soil, is not expected to expedite groundwater cleanup relative to on-going, intrinsic biodegradation processes.

Cleanup times were estimated in the FS report for the groundwater extraction alternatives, GW3 and GW7, using the pore volume flush method for both the source areas (i.e., the areas subjected to hydraulic control) and the down gradient plume areas (i.e., areas not subject to hydraulic control). The pore volume flush approach is based upon a simplified soil/water partitioning equation, which considers contaminant removal via groundwater extraction within the constraints of adsorption/desorption processes. The pore volume approach does not account for contaminant reduction via biodegradation or other attenuation processes. The results of cleanup time estimates are presented in Tables 2 and 6 in Appendix C of the FS report, respectively. These estimates are applicable to alternatives GW3 and GW7, which are similar in technical approach. For onsite contamination, cleanup times for trichloroethene, benzene, tetrachloroethene, and 1,2,4-trichlorobenzene were calculated at ADC, HRDD, and ARC. Cleanup times for trichloroethene and 1,2,4-trichlorobenzene were calculated downgradient of ADC and downgradient of ARC. For onsite contamination, cleanup time estimates ranged from 307 years to 28,202 years. Cleanup time estimates for areas downgradient of the sites ranged from 172 years to 7,595 years. In summary, the results of these estimates indicate that groundwater extraction would not attain cleanup levels in a reasonable time frame.

Biodegradation was also observed for groundwater contaminants. Estimates for cleanup rates due to biodegradation were calculated using the EPA's BIOSCREEN model, which is a very simple, screening-level model that is intended for limited use as a decision support tool. The BIOSCREEN Evaluation Summary is presented in Appendix C of the FS. The BIOSCREEN model was used to obtain rough, conservative estimates for biodegradation rate constants associated with contaminants at the ADC and ARC areas. The model considered the operational periods of the sites, groundwater data, groundwater flow paths, groundwater velocity estimates, contaminant retardation factors, and approximate plume length and width. For modeling purposes, it was conservatively assumed that infinite sources exist at the sites. At least two data points, a "source" well and a "downgradient" well, were used for each simulation. The biodegradation half-life was considered a variable, which was adjusted until a good match was achieved between the observed data and the model results. The biodegradation decay rate constant for total chlorinated volatile organic compounds (CVOCs) was roughly estimated to be 0.14 per year. The cleanup times were then calculated using the first-exponential biological decay equation considered per p. 3-10 of the Navy monitored natural attenuation (MNA) evaluation guidelines (Navy, September 1998):

$$C_{TD} = C_o e^{-\lambda t}$$

where:
C_{TD} is the tracer-normalized contaminant concentration at some point

downgradient along the flowpath
C_o is the initial contaminant concentration
λ is the biodegradation decay rate constant
t is time

The biodegradation decay rate constant for CVOCs was used because it is assumed that CVOCs will drive the groundwater cleanup times. The highest CVOC concentrations detected in groundwater of each area (from the RI report) were used for the value of C_o and a target CVOC cleanup value of 1 ug/L (based upon the vinyl chloride MCL) was used for the value of C_{TD}. This equation assumes no additional source contaminants contribute to the plume, which is the case at the completion of the soil remedy. The clean up time estimates for the on-site source areas range from 48 years to 76 years. The cleanup time estimates for areas downgradient of the sites range from 37 to 38 years. The results of these cleanup time estimates, when compared to the above estimates completed using the pore volume exchange method, suggest that: 1) on-going, intrinsic biodegradation processes could contribute more toward reducing VOC concentrations in groundwater than groundwater extraction and 2) groundwater extraction may not significantly effect cleanup time.

Although the MCLs will most likely not be met for a long time, groundwater contaminants at the sites are not expected to significantly impact human health or the environment. The groundwater contaminants do not impact the two regional aquifers (the Old Bridge aquifer and Farrington aquifer) as described in Section 2. Groundwater at the sites is currently not used as a potable water source and is not likely to be used in the future due to the low specific capacities of the aquifer. Of the six wells tested, only three wells had the capacity to produce 0.25 gpm sustained yield, and the three other wells were pumped dry at rates below 0.25 gpm.

Contaminated groundwater is not expected to impact the nearby wetlands since the groundwater velocities at the sites are extremely slow. Therefore, the mass of contaminants that will reach the wetlands will be very small. The calculated groundwater flow velocities were 96.4 ft/yr in HRDD, 106 ft/yr in ARC, 51.4 ft/yr in ADC, and 45.0 ft/yr in SPD. These velocities are expected to be upper limit values.

VOCs, which are the primary groundwater contaminants, were not detected in the surface water sample collected from the wetland during the remedial investigation. Additional samples were later collected in the wetlands during a storm event. These samples contained VOCs that exceeded surface water quality limits but these contaminants were most likely due to stormwater run-off from the sites instead of from contaminated groundwater discharge since the samples were collected during a storm event. Sediment samples were also collected from the wetlands at depths up to 42 inches bgs. VOCs were only sporadically detected, usually at fairly low levels. Most of the sediment VOC detections were in samples from 0-6 inches bgs, which suggests that contaminant migration to the wetland is most likely the result of contaminated surface run-off and not a result of groundwater discharge to the surface water. Since the soil remedy includes the removal of surface soils, contaminant run-off into the wetlands will be significantly reduced.

6.4 Demonstration that No Other Remedial Technologies Could Reliably, Logically or Feasibly Attain the Cleanup Levels at the Sites Within Reasonable Time Frame

The FS report identified and evaluated multiple technologies for treatment of groundwater. Seven groundwater alternatives were developed in the FS:

GW1 - No Action
GW2 - Limited Action (use restrictions and periodic monitoring)
GW3 - Groundwater Cut-off Wall
GW4 - Permeable Reactive Barrier
GW5 - In-situ Chemical Oxidation
GW6 - In-situ Air Sparging
GW7 - Groundwater Extraction and Treatment

These alternatives were evaluated and initially screened; three alternatives (GW1, GW3, GW 7) were retained for detailed evaluation in Section 4 of the FS report. The FS evaluation concluded that these alternatives, which included a range of technologies, would not achieve the required cleanup levels effectively and reliably within a reasonable time frame. The rationales for the technical impracticability of the FS technologies are summarized below:

<u>Alternative 1- No Action</u>
Under this alternative, no further action for groundwater would be implemented. Because there is no long term monitoring under this alternative, the nature and extent of the contaminants after the removal of the saturated zone soils would not be known. It is expected that ARARs would not be attained for a very long time. Since no further action would be implemented, contamination would only be reduced through natural biodegradation and attenuation processes.

<u>Alternative GW3 - Groundwater Cut-off Wall</u>
Under Alternative GW3, a low-permeable slurry cut-off wall and groundwater extraction and treatment system would hydraulically control the groundwater contamination source areas. The groundwater extraction system, which consists of a groundwater interceptor trench, would remove some contaminant mass from groundwater inside the slurry wall containment area; however, very little contaminant mass would be removed over the long term because of the low permeability of the soil. The FS report indicates that less than one gpm would be extracted by the interceptor trench during average, steady-state conditions. At this rate, the pore volume exchange rate would be approximately 1 every 20 years. The calculations using the pore volume flush method determined that up to approximately 5,000 pore volumes would need to be extracted to achieve the MCLs (for 1,2,4-trichlorobenzene at ARC). As indicated in Appendix C of the FS, the estimated number of pore volume flushes required for cleanup is driven by the high soil/water partition coefficient (i.e., strong tendency to adsorb to soil particles) and low

groundwater MCL associated with 1,2,4-trichlorobenzene. Section 6.3 shows that the groundwater extraction and treatment system would not improve the conditions at the sites within a reasonable time frame, since cleanup times would be controlled by biodegredation processes and not by the groundwater extraction and treatment system.

<u>Alternative GW7 - Groundwater Extraction and Treatment</u>
Alternative GW7 also involves the construction of a groundwater interceptor trench and associated extraction/treatment system to achieve hydraulic control and removal of contaminant mass from the groundwater plume area. The FS report indicates that approximately 2 gpm of groundwater would be extracted. At this rate, the pore volume exchange rate would be approximately one every ten years. The calculations using the pore volume flush method determined that up to approximately 5,000 pore volumes would need to be extracted to achieve the MCLs (for 1,2,4-trichlorobenzene at ARC). As indicated in Appendix C of the FS, the estimated number of pore volume flushes required for cleanup is driven by the high soil/water partition coefficient (i.e., strong tendency to adsorb to soil particles) and low groundwater MCL associated with 1,2,4-trichlorobenzene. Section 6.3 shows that the groundwater extraction and treatment system would not improve the conditions at the sites within a reasonable time frame, since cleanup times would be controlled by natural biodegradation and attenuation processes and not by the extraction and treatment system.

<u>Supplemental Alternative GW2a - Long-term Monitoring and Institutional Controls</u>
Given that groundwater quality will not likely be reliably and effectively restored using active remedial technologies (i.e., Alternatives GW3 and GW7), and the soil remedy will significantly reduce the groundwater contamination by removal of waste sources and by direct removal of groundwater below the saturated zone, a supplemental alternative encompassing long-term monitoring and institutional control was subject to further consideration and evaluation. This alternative, designated as GW2a - Long-term Groundwater Monitoring and Institutional Control, is a modified version of alternative GW2 from the FS. This alternative would be coupled with a source removal remedy for soils and include a TI waiver addressing the likelihood that none of the active remedial alternatives would achieve ARARs in a reasonable time frame. Based upon the information presented in this document, the overall protection of human health and environment that could be achieved by GW3 and GW7 is comparable to that offered by GW2a. Under GW2a, routine groundwater monitoring would provide data to: 1) verify the effectiveness of source area removal under a soil remedy, 2) verify the absence of significant pathways for human health risk and environmental impact, and 3) track changes in underlying and downgradient groundwater quality over time. Data from the groundwater monitoring also could be used to evaluate and refine cleanup time estimates for the sites using more precise techniques (e.g., statistical trend analysis). For cost estimation purposes, it is assumed that quarterly monitoring would occur for the first two years and semi-annual monitoring would occur for years 3 to 30. The costs for this alternative were taken from the groundwater monitoring section of the GW3 and GW7 FS cost estimates.

6.5 Estimated Costs of Alternatives

Alternative	Capital Costs	Annual O&M Costs (30 years)	Total Present Worth
GW1	$0	$0	$0
GW3	$3,080,000	$100,000 (years 1 and 2) $82,000 (years 3 to 30)	$4,133,000
GW7	$1,383,000	$147,000 (years 1 and 2) $129,000 (years 3 to 30)	$3,020,000
GW2a	$0	$42,000 (years 1 and 2) $24,000 (years 3 to 30)	$334,000

Section 7
References

CDM, Revised Final Feasibility Study for Soil and Groundwater, Horseshoe Road Complex Superfund Site, Remedial Investigation/Feasibility Study, Sayreville, New Jersey, Prepared for U.S. Environmental Protection Agency. September 2002.

CDM, Final Remedial Investigation Report, Horseshoe Road Complex Superfund Site, Remedial Investigation/Feasibility Study, Sayreville, New Jersey, Prepared for U.S. Environmental Protection Agency. May 1999.

Navy, Technical Guidelines for Evaluating Monitored Natural Attenuation of Petroleum Hydrocarbons and Chlorinated Solvents in Groundwater at Naval and Marine Corp Facilities. Department of Navy, September 1998.

TABLE 2-1
CHEMICAL-SPECIFIC ARARS/TBCS
HORSESHOE ROAD COMPLEX AND ATLANTIC RESOURCES SITES

Standard, Requirement, Criterion, Or Limitation	Citation Or Reference	Description	Status	Comments
FEDERAL				
Soil: Toxic Substances Control Act	Requirements for PCB Spill Cleanup (40 CFR 761.125)	Establishes PCB cleanup levels for soils and soil surfaces.	Relevant and Appropriate	Applicable to spills of materials containing PCBs at concentrations of 50 ppm or greater.
Surface Water: Clean Water Act (CWA).	33 USC 1251 et.seq.	Restoration and maintenance of chemical, physical, and biological integrity of the nation's surface waters.	Relevant and Appropriate	Criterion available for water and fish ingestion, and fish consumption for human health. State criterion are also available.
Groundwater: Maximum Contaminant Levels (MCLs)	40 CFR Part 141	Maximum permissible levels of contaminants in water which is delivered to any user of a public water system.	Relevant and Appropriate	Applicable to determining whether groundwater contamination from the Site used for drinking requires treatment to reduce contaminants to levels below the MCLs.
NEW JERSEY STATE				
Soil: Cleanup Standards for Contaminated Sites: Soil Cleanup Criteria (NJSCC).	NJAC 7:26D	Soil criteria developed based on protection of human health or groundwater quality used for developing site-specific cleanup levels (updated May 12, 1999).	TBC	Provides basis and procedure to develop soil cleanup objectives and determine soil cleanup goals.

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TABLE 2-1
CHEMICAL-SPECIFIC ARARS/TBCS (continued)
HORSESHOE ROAD COMPLEX AND ATLANTIC RESOURCES SITES

Standard, Requirement, Criterion, Or Limitation	Citation Or Reference	Description	Status	Comments
NEW JERSEY STATE (continued)				
Sediment: Guidance for Sediment Quality Evaluations - November 1998	N/A	Establishes practical guidance for evaluations to be used in ecological risk assessment process under Site Remediation Program.	TBC	Used for determining sediment cleanup criteria (freshwater and marine) for remedial actions.
Groundwater: New Jersey Primary Drinking Water Standards	NJAC 7:10-5	Maximum permissible levels of contaminants in water which is delivered to any user of a public water system.	Applicable	Applicable to determining whether groundwater contamination from the Site used for drinking requires treatment to reduce contaminants to levels below the MCLs.
Groundwater Quality Criteria	NJAC 7:9-6.7	Lists the maximum permissible levels of contaminants in groundwater.	Applicable	Applicable for protecting human health.
Hazardous Waste: Identification and Listing of Hazardous Waste.	NJAC 7:25G-5	Describes methods for identifying hazardous wastes and lists known hazardous wastes.	Applicable	Applicable to determining whether wastes are considered hazardous.

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TABLE 2-2
LOCATION-SPECIFIC ARARs/TBCs
HORSESHOE ROAD COMPLEX AND ATLANTIC RESOURCES SITES

Standard, Requirement, Criterion, Or Limitation	Citation Or Reference	Description	Status	Comments
FEDERAL				
Wetlands and Coastal Zone: Protection of Wetlands	Executive Order No. 11990	Requires Federal agencies to take action to avoid adversely impacting wetlands wherever possible and to minimize wetlands destruction.	Applicable	Applicable to remedial actions that affect wetland areas.
Floodplain Management	Executive Order No. 11988	Requires Federal agencies to evaluate the potential effects of actions if may take in floodplain to avoid adversely impacting floodplains wherever possible, and to ensure that its planning programs and budget request reflect consideration of flood hazards and floodplain management, including the restoration and preservation of such land areas as natural undeveloped floodplains	Applicable	Applicable to remedial actions that affect floodplains.
Fish And Wildlife: Endangered Species Act.	16 USC 1531	Requires Federal agencies to ensure that actions they authorize, fund or carry out are not likely to jeopardize the continued existence of endangered/threatened species or adversely modify or destroy the critical habitats of such species.	Applicable	Applicable to remedial activities that may affect endangered or threatened species that may exist in areas affected by the remedial activity.
NEW JERSEY STATE				
Fish and Wildlife: Endangered and Threatened Species	NJAC 7:13-3.9	Identifies endangered and threatened species and species of special concern.	Applicable	Applicable if activities impact the habitat areas of any such species.

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TABLE 1-8
PRELIMINARY CLEANUP GOALS FOR GROUNDWATER
HORSESHOE ROAD COMPLEX AND ATLANTIC RESOURCES CORPORATION SITES
SAYREVILLE, NEW JERSEY

Analyte[a]	NJ Primary Drinking Water Standards (µg/L)	NJ GW Quality Criteria Class II A Groundwater (µg/L)	NJ Saltwater Criteria Human Health and Aquatic Life[b] (µg/L)	Maximum Groundwater Background Levels[c] (µg/L)	Selected Preliminary Groundwater Cleanup Goals (µg/L)
Volatile Organic Compounds					
Vinyl Chloride	**2**	**2**	525 (hc)	NA	2
Methylene Chloride	**3**	**3[d]**	1,600 (hc)	NA	3
1,1-Dichloroethene	**2**	**2**	32 (hc)	NA	2
1,1-Dichloroethane	**50**	**50**	NA	NA	50
cis-1,2-Dichloroethene	**70**	**70[d]**	NA	NA	70
Chloroform	100	**6**	470 (hc)	NA	6
1,2-Dichloroethane	**2**	**2**	99 (hc)	NA	2
1,1,1-Trichloroethane	**30**	**30**	NA	NA	30
Trichloroethene	**1**	**1**	81 (hc)	NA	1
Benzene	**1**	**1**	71 (hc)	NA	1
Tetrachloroethene	**1**	**1**	4.29 (hc)	NA	1
1,1,2,2-Tetrachloroethane	**1**	**1[d]**	NA	NA	1
Toluene	**1,000**	**1,000**	200,000 (h)	NA	1,000
Chlorobenzene	NA	**50[d]**	21,000 (h)	NA	50
Xylenes (Total)	**1,000**	**1,000[d]**	NA	NA	1,000
Semivolatile Organic Compounds					
bis(2-Chloroethyl)ether	NA	10	**1.4** (hc)	NA	1.4
1,4-Dichlorobenzene	**75**	**75**	3,159 (h)	NA	75
Nitrobenzene	NA	**10**	1,900 (h)	NA	10
Isophorone	NA	**100**	NA	NA	100
1,2,4-Trichlorobenzene	**9**	**9**	113 (h)	NA	9
Inorganic Analytes					
Aluminum	NA	200	NA	**1,490**	1,490
Antimony	6	20	4,300 (h)	**18**	18
Arsenic	10	8	0.136 (hc)	**16**	10
Beryllium	**4**	20	NA	2	4
Cadmium	5	4	NA	**8**	8

TABLE 1-8
PRELIMINARY CLEANUP GOALS FOR GROUNDWATER
HORSESHOE ROAD COMPLEX AND ATLANTIC RESOURCES CORPORATION SITES
SAYREVILLE, NEW JERSEY

Analyte[a]	NJ Primary Drinking Water Standards (μg/L)	NJ GW Quality Criteria Class II A Groundwater (μg/L)	NJ Saltwater Criteria Human Health and Aquatic Life[b] (μg/L)	Maximum Groundwater Background Levels[c] (ug/L)	Selected Preliminary Groundwater Cleanup Goals (μg/L)
Chromium	**100**	**100**	3,230 (h)	9	100
Iron	NA	300	NA	**49,000**	49,000
Lead	15	**10**	NA	5	10
Manganese	NA	50	100 (h)	**1,480**	1,480
Nickel	NA	**100**	3,900 (h)	98	100
Thallium	2	10	6.22 (h)	5	5

Sources:

New Jersey Safe Drinking Water Act (NJSDWA) Primary Drinking Water Standards
New Jersey Groundwater Quality Standards (N.J.A.C. 7:9-6)
Surface Water Quality Standards, Critiera Applicable to New Jersey, April 30, 1998

Notes:

a Analytes were selected from list of COPCs in the RI.
b The more stringent (lower) of the Human Health and Aquatic Criteria was selected
c The maximum groundwater levels for inorganics were determined from 4 background wells (GW-1, CW-12, CW-13, and CW-14 for 2 rounds of sampling)
d An Interim Specific Criteria based on Safe Drinking Water Act Maximum Contaminant Level (MCL)
NA Not Available
(h) Noncarcinogenic effect-based human health criteria
(hc) Human carcinogenic effect-based human health criteria

Bolded values indicate the selected preliminary groundwater cleanup goal for each contaminant

TABLE 2-4
QUANTITY ESTIMATES OF CONTAMINATED SOILS, SEDIMENTS AND CONCRETE
HORSESHOE ROAD COMPLEX AND ATLANTIC RESOURCES SITES

Location	"Hot Spot" Surface Soils (CY)	Surface Soils (CY)	Subsurface Soils (CY)	Sediment (CY)	Concrete Slab (CY)
Horseshoe Road Drum Dump	0	13,467	0	-	-
Atlantic Development Corporation	203	4,537	7,065	-	585
Sayreville Pesticide Dump	108	24,160	3,000	-	-
Atlantic Resources Corporation	83	3,615	5,950	-	796
TOTAL	394	45,779	16,015	200	1,381

Notes:
Surface soils are located from ground surface to water table depth.
Portion of HRDD surface soils (400 CY) are located outside footprint of dump area.
Subsurface soils are located below the water table and are considered groundwater source areas.

Table 2: Cleanup Time Summary
Horeshoe Road Complex Superfund Site
Sayreville, New Jersey

	Cleanup Time (Years)		
Constituent	ADC	HRDD	ARC
Trichloroethene	3,251	307	2,571
Benzene	2,605	443	908
Tetrachloroethene	3,556	274	4,372
1,2,4-Trichlorobenzene	28,202		22,438

Note:

1. Cleanup Time (yrs) = Pore Volume * Distance (ft) /Velocity (ft/yr)

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Appendix

Table 6: Cleanup Time Summary for Downgradient Areas
Horeshoe Road Complex Superfund Site
Sayreville, New Jersey

	Cleanup Time (Years)	
Constituent	Downgradient of ADC	Downgradient of ARC
Trichloroethene	1,488	172
1,2,4-Trichlorobenzene	1,318	7,595

Note:

1. Cleanup Time (yrs) = Pore Volume * Distance (ft) /Velocity (ft/yr)

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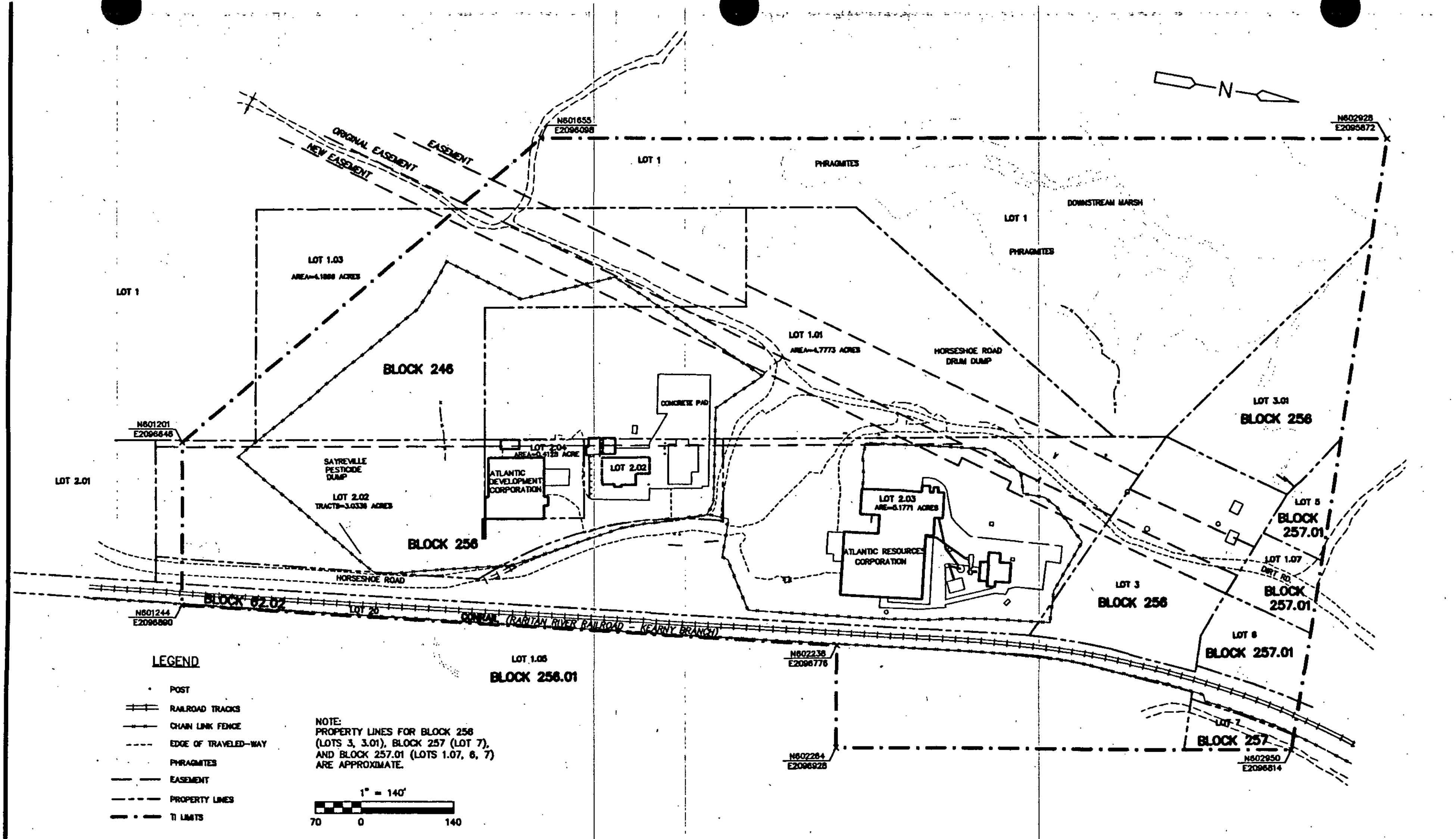

FIGURE 1

SPATIAL AREA OVER WHICH TI WAIVER IS APPLIED

HORSESHOE ROAD COMPLEX AND ATLANTIC RESOURCES SITES
SAYREVILLE, NEW JERSEY
PROJECT NO. 3220-013

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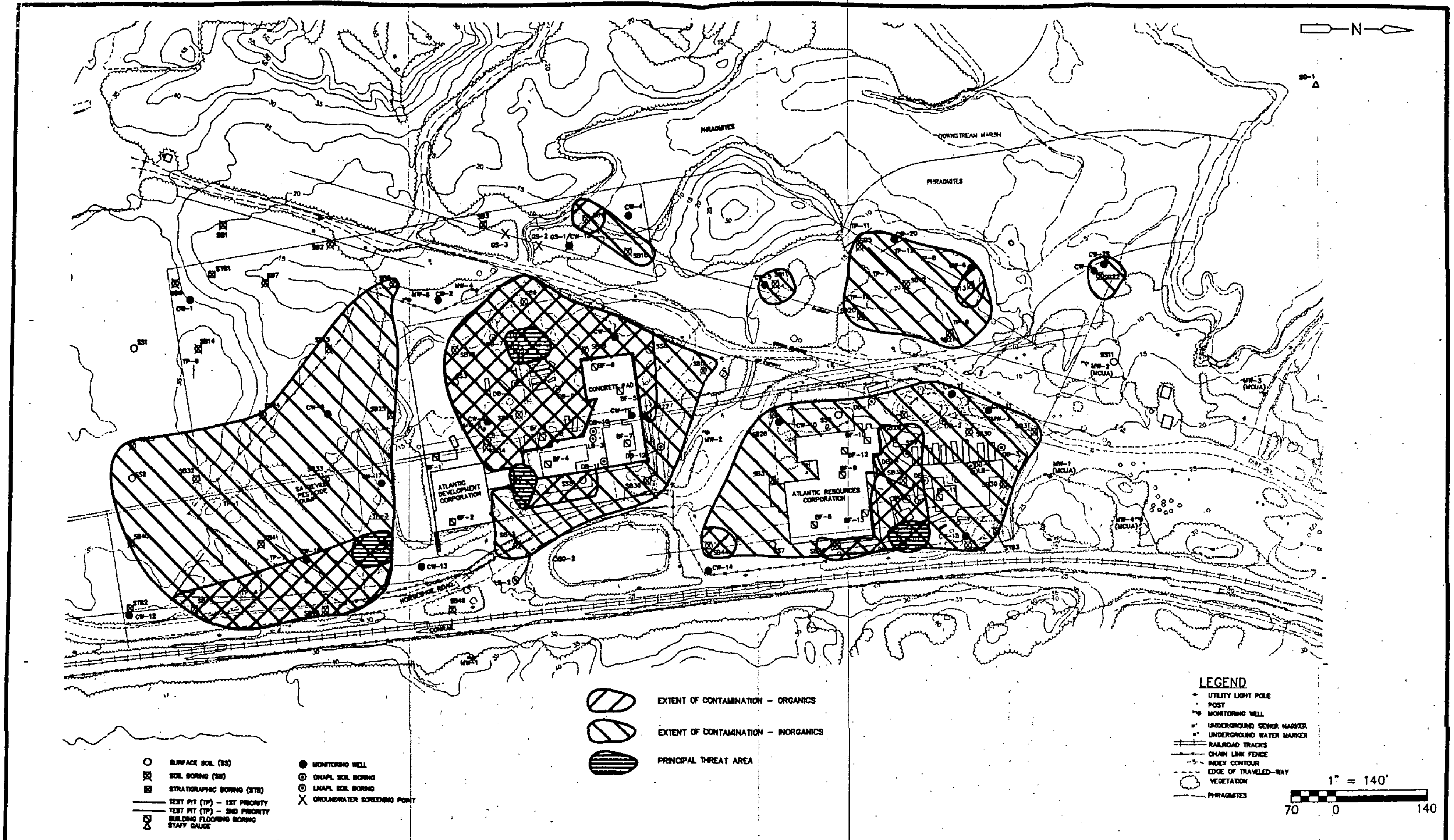

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FIGURE 1-26

EXTENT OF SURFACE SOIL CONTAMINATION

HORSESHOE ROAD COMPLES SITE
SAYREVILLE, NEW JERSEY
PROJECT NO. 3220-013

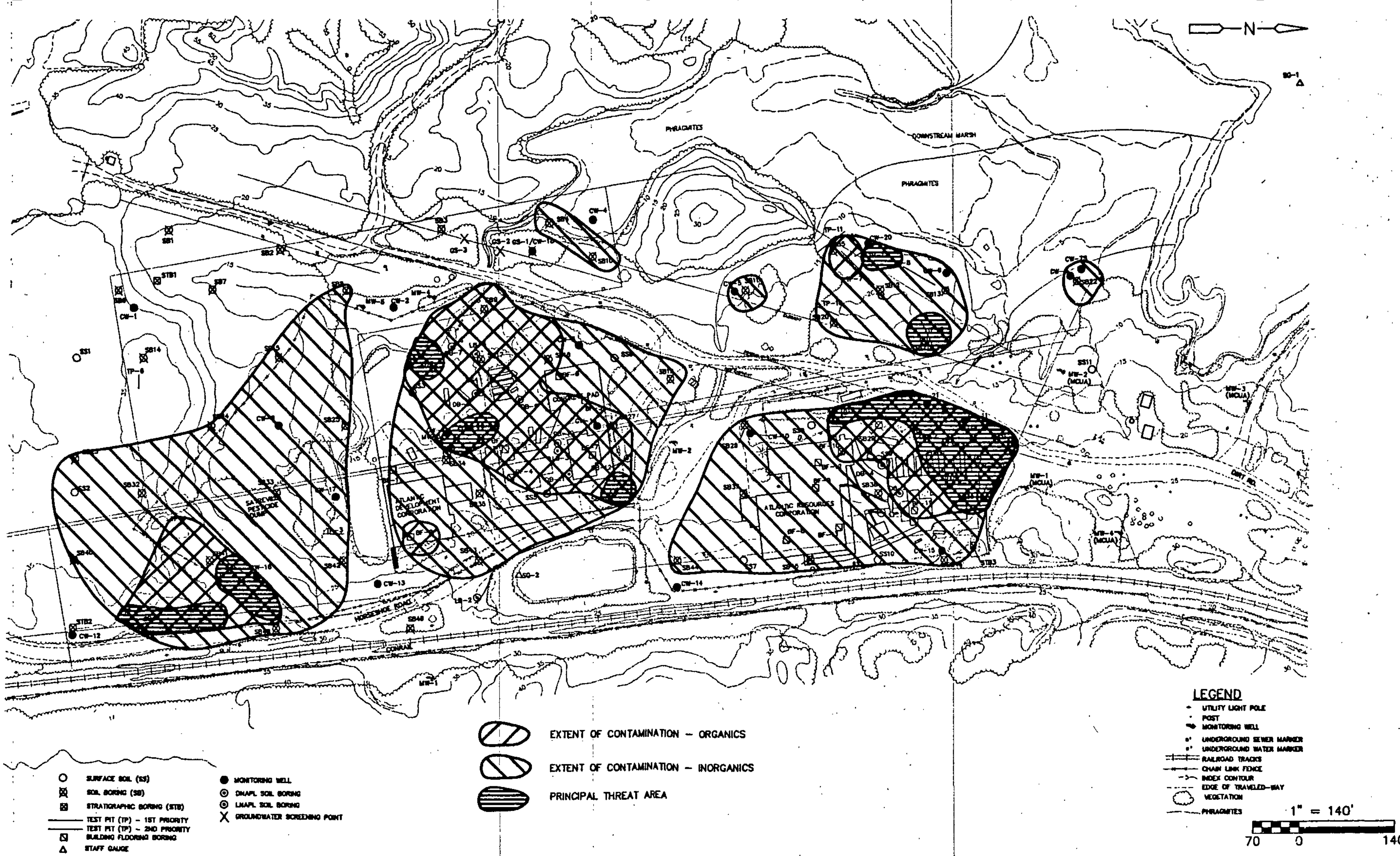

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FIGURE 1-27

EXTENT OF SUBSURFACE SOIL CONTAMINATION

HORSESHOE ROAD COMPLEX SITE
SAYREVILLE, NEW JERSEY
PROJECT NO 3220-013

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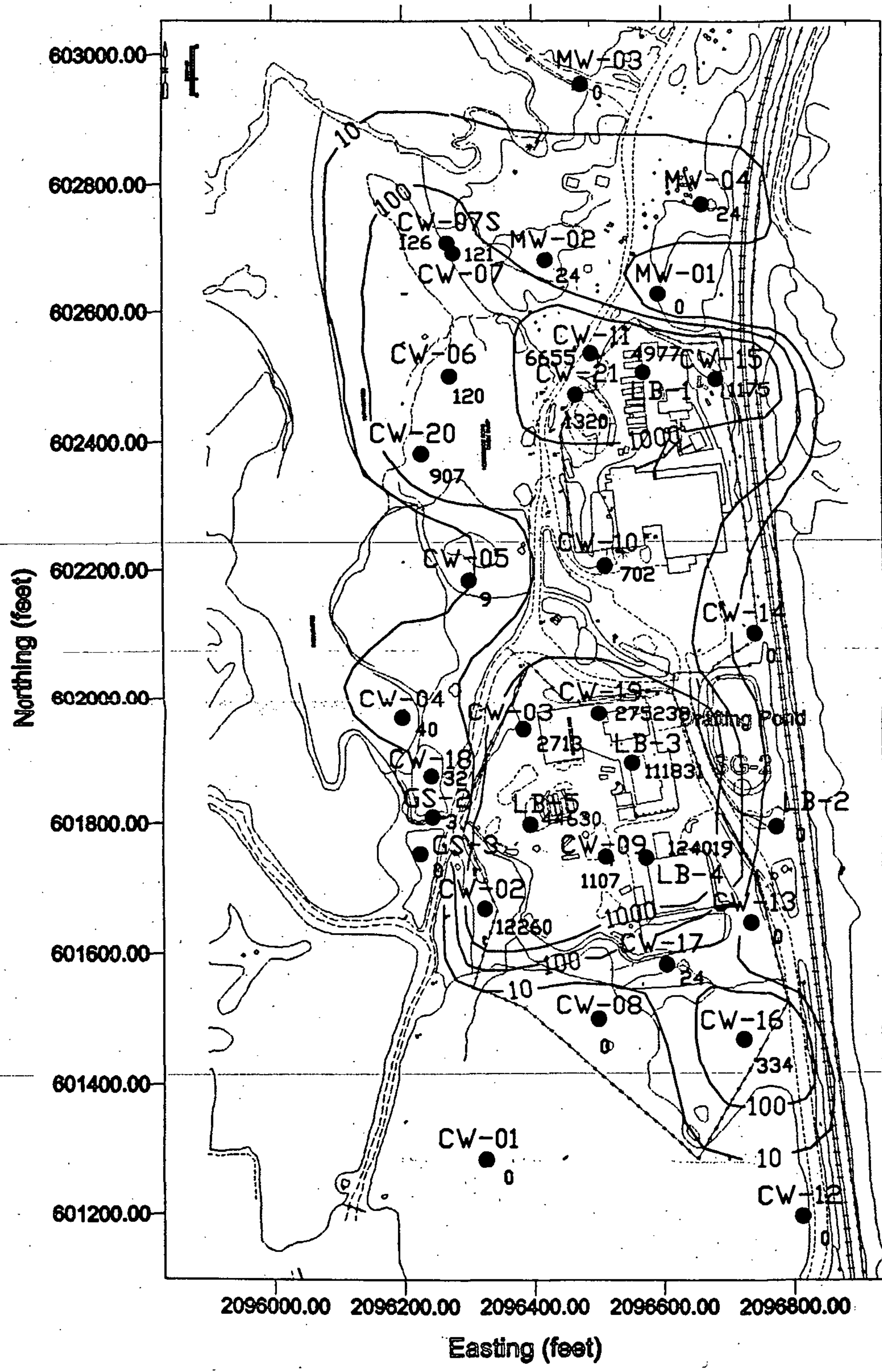

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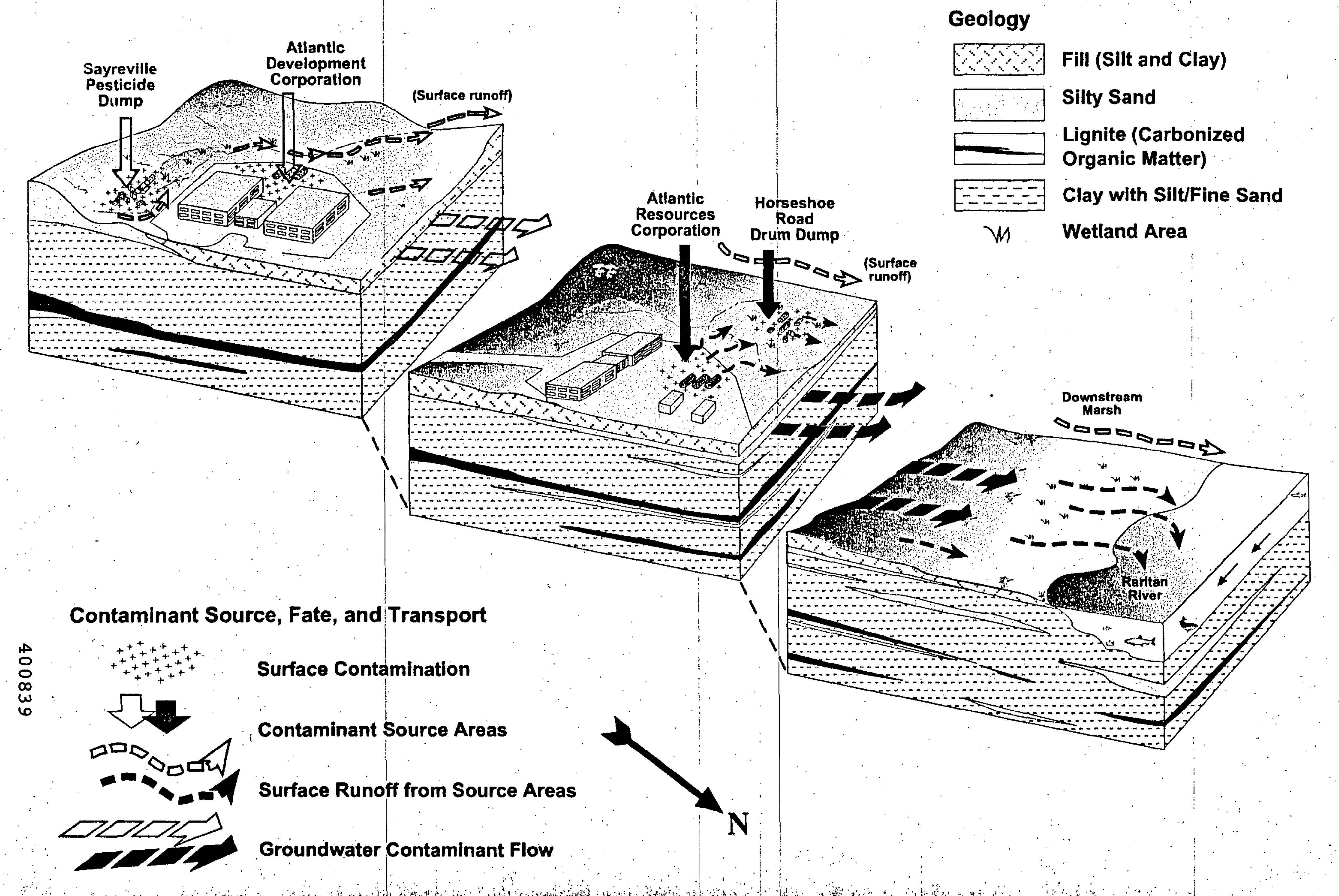
CDM FEDERAL PROGRAMS CORPORATION
a subsidiary of Camp Dresser & McKee Inc.

FIGURE 4-54
TOTAL VOC EXCEEDANCES IN GROUNDWATER (UG/L)
ALL SAMPLE ROUNDS

HORSESHOE ROAD COMPLEX SITE
WORK ASSIGNMENT 085-2COBT

Figure 6-1. Three-Dimensional Interpretation of Contaminant Source, Fate, and Transport at the Horseshoe Road Site



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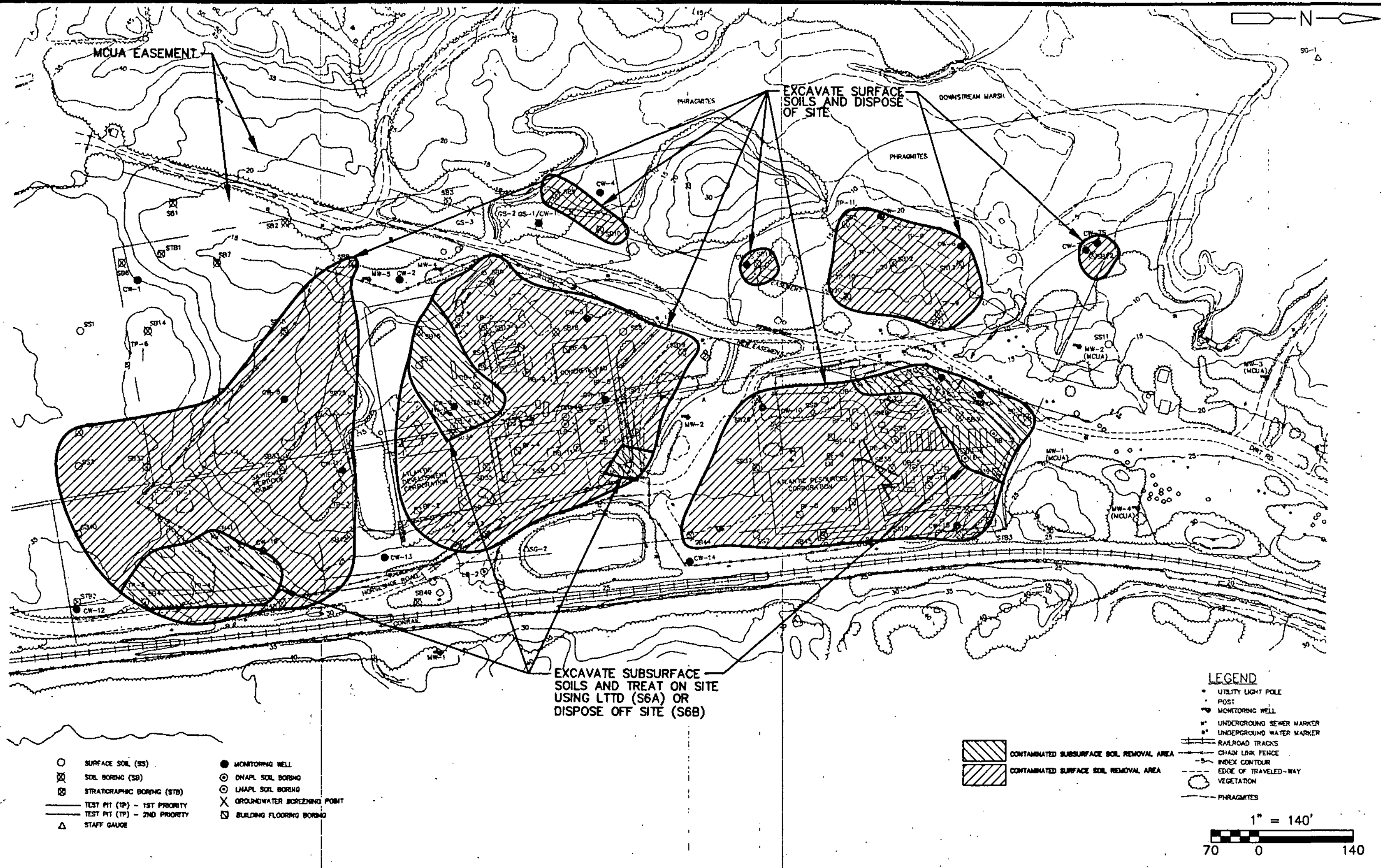

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FIGURE. 4-3

CONCEPTUAL SITE PLAN FOR ALTERNATIVE S6
EXCAVATION WITH ON-SITE LTTD TREATMENT AND BACKFILL (S6A) OR OFF-SITE DISPOSAL (S6B)
HORSESHOE ROAD COMPLEX AND ATLANTIC RESOURCES SITES
SAYREVILLE, NEW JERSEY
PROJECT NO. 3220-013